Organic semiconductors will create cheaper, greener devices

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Semiconductors are used in devices such as LED TVs to convert electric current to light; and in photovoltaic cells, commonly known as solar panels, which absorb light energy and convert it into electricity.

Research into organic semiconductors could lead to more efficient LED TVs and flexible solar cells that are cheaper to make and take less energy to produce according to researchers at the University of Bath.

Semiconductors are used in devices such as LED TVs to convert electric current to light; and in photovoltaic cells, which absorb light energy and convert it into electricity. Traditionally 'inorganic semiconductors', often

based on silicon, are used in such devices. However these are relatively difficult to make and take a lot of energy to produce.

It is estimated that solar cells made from silicon can take a year to pay back the total energy consumed in their manufacture.

Despite efforts over the last three decades to develop organic semiconductors on a mass scale, scientists have been challenged by the fact that this type of semiconductor is less efficient at conducting electricity.

Now, a team from the University of Bath, collaborating with scientists in Germany and The Netherlands, has identified how the electronics industry could overcome some of the existing problems associated with using organic semiconductors.

Dr Daniele Di Nuzzo, Research Officer in Physics at the University and first author on the paper, explained: "Conventional semiconductor devices are tricky to make because they first require the production of crystalline materials. Because of this, they also use up a lot of energy to be produced.

"In contrast, organic semiconductors can be processed via printing techniques. For example, organic semiconducting polymers can be dissolved in a solvent to make an electronic ink to be printed onto a surface.

"However they have a disordered structure and conduct electrical charges less well than silicon."

One way of improving the electrical properties of organic semiconductors is to mix them with 'doping' molecules, which work by adding electrical charges to the polymer.

Dr Di Nuzzo added: "It's difficult currently to implement the doping technique in an effective way to produce organic semiconductor devices that work with high performances. Our research shows why this is the case and suggests how we can improve the performance of these materials."

The study, published in the journal *Nature Communications*, found that the size and geometrical position of the doping molecule used had an effect on the efficiency of the semiconductor material.

Dr Enrico Da Como from the University's Department of Physics, led the study. He explained: "The organic polymer consists of a chain of units which is mixed with the doping molecule before it is printed onto a surface. We found that the doping molecule can bind to the polymer in several different orientations, some of which make a more effective semiconductor than others.

"Our work suggests that if you use a larger doping molecule, you limit the number of ways it can bind to the polymer, making the efficiency of the semiconductor more consistent."

More information: Daniele Di Nuzzo, et al "How intermolecular geometrical disorder affects the molecular doping of donor–acceptor copolymers" is published in *Nature Communications* 6, Article number: 6460 DOI: 10.1038/ncomms7460

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